
Analysis review of a miniature active filter based on the photovoltaic power source

MANISH KHEMARIYA ¹, ANAND SINGH ², NAVEEN ASATI³

1. Professor, Department of Electrical & Electronics Engineering, LNCT, BHOPAL (M.P.)
 2. Associate Professor Department of Electrical& Electronics Engineering, LNCT, BHOPAL (M.P.)
 3. Associate Professor, Department of Electrical& Electronics Engineering, LNCT, BHOPAL (M.P.)
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ABSTRACT:

In this paper, the analysis of shunt active filters based on a solar cell power source to complement the active filter is reviewed. Due to the occurrence of non-linear loads and the inverter connected to the photovoltaic system, harmonics appear in the current and voltage. Therefore, in order to reduce the harmonic connection, a shunt-activated filter is connected between the three-phase inverter and the non-linear load based on the semiconductor device at the common coupling point. Power quality is improved by reducing overall harmonic distortion. Shunt-activated filters connected to photovoltaic systems have been demonstrated using MATLAB simulation models. From the results obtained, based on two cases, the first is only the non-linear load connected and the second is the load connected to the shunt active power filter at the base of the solar cell power supply. It is observed that solar cell based PV system with shunt active filter provides low total harmonic distortion.

KEYWORDS:

SOLAR PV, INVERTER, FILTER, MATLAB, THD, LOAD FILTERS .

Basic Active Power Filter

INTRODUCTION

Modern electrical systems, due to wide spread of power conversion units and power electronics equipment's, causes an increasing harmonics disturbance in the ac mains currents. Power Quality (PQ) is an important measure of an electrical power system. The term PQ means to maintain purely sinusoidal current wave form in phase with a purely sinusoidal voltage wave form. The power generated at the generating station is purely sinusoidal in nature. The deteriorating quality of electric power is mainly because of current and voltage harmonics due to wide spread application of the. power electronics based equipment's which include adjustable-speed motor drives, electronic power supplies, DC motor drives, battery chargers, electronic ballasts are responsible for the rise in power quality related problems [1] [2], [3]. These nonlinear loads absorb non-sinusoidal currents and generally consume reactive power. Harmonic currents produced by non linear loads are injected back into power distribution systems through the point of common coupling. The controller is the main part of the active power filter operation and has been a subject of many researches in recent years[16–20]. Conventional PI voltage and current controllers have been used to control the harmonic current and dc voltage of the shunt

APF. However, the conventional PI controller requires precise linear mathematical model of the system, which is difficult to obtain under parameter variations, nonlinearity, and load disturbances. In recent years, fuzzy logic controllers have generated a great deal of interest in certain applications. The advantages of fuzzy logic controllers are: robustness, no need to accurate mathematical model, can work with imprecise inputs, and can handle non-linearity. In this paper, review analysis of shunt active power filter .

Figure 1a shows the basic compensation principle of the shunt active power filter. It is controlled to draw or supply a compensating current i_c from or to the utility, so that it cancels current harmonics on the ac side. Figure 2 shows the different waveforms. Curve A is the load current waveform and curve B is the desired main current. Curve C shows the compensating current injected by the active filter containing all the harmonics, to make the mains current sinusoidal. In this manner a shunt active power filter can be used to eliminate current harmonics and reactive power compensation [5].

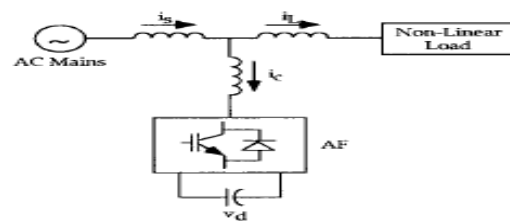


Figure 1 Block diagram of basic active power filter from figure 1a the instantaneous currents can be written as ;

$$i_s(t) = i_L(t) - i_c(t)$$

The source voltage is given by

$$v_s(t) = V_m \sin \omega t$$

if a nonlinear load is applied, then the load current will have a fundamental component, and the harmonic components can be represented as;

$$i_L(t) = \sum_{n=1}^{\infty} I_n \sin(n\omega t + \phi_n)$$

$$i_L(t) = I_1 \sin(\omega t + \phi_1) + \sum_{n=2}^{\infty} I_n \sin(n\omega t + \phi_n)$$

Instantaneous load power can be given as

$$p_L(t) = v_s(t) * i_L(t)$$

$$p_L(t) = V_m I_1 \sin^2 \omega t * \cos \phi_1 + V_m I_1 \sin \omega t * \cos \omega t * \sin \phi_1$$

$$+ V_m \sin \omega t * \sum_{n=2}^{\infty} I_n \sin(n\omega t + \phi_n)$$

$$p_L(t) = p_f(t) + p_r(t) + p_h(t)$$

From equation (4) real (Fundamental) power is drawn by

the load

$$p_f(t) = V_m I_1 \sin^2 \omega t * \cos \phi_1 = v_s(t) * i_s(t)$$

From equation (6) the source current supplied by the source, after compensation

$$i_s(t) = \frac{p_f(t)}{v_s(t)} = I_1 \cos \phi_1 \sin \omega t = I_{sm} \sin \omega t$$

Also there are some switching losses in the PWM converter. Hence, the utility must supply a small overhead for the capacitor leaking and converter switching losses in addition to the real power of the load.

Hence, total peak current supplied by the source

$$I_{sp} = I_{sm} + I_{sL}$$

If the active filter provides the total reactive and harmonic power then $i_s(t)$ will be in phase with the utility voltage and pure sinusoidal. At this time the active filter must provide the following compensation current:

$$i_c(t) = i_L(t) - i_s(t)$$

Hence for the accurate and instantaneous compensation of reactive and harmonic power, it is necessary to calculate $i_s(t)$, the fundamental component of load current, as the reference current

LITERATURE REVIEW

[1] Dr. S. Srinatha, et. al, The use of nonlinear loads in current days have become tremendous that offers an alarm sign to energy device and energy engineers in phrases of fine of strength. Because of huge quantity of non-linear energy electronic gadget harmonic distortion is frequently encountered thru the utilities in every day. The cause of energetic clear out is to take away the harmonics present in the electrical signal ensuing in sustaining the fine of the electricity supply within the system. DSP managed Shunt energetic filter out is applied on this paper to do away with harmonics and compensate reactive

strength resulting from nonlinear load. Discrete Fourier Transformation is Used to generate reference supply cutting-edge.

[2] Priyadharshini et. al, This paper affords a new adaptive hysteresis band controller for three segment shunt energetic strength filters applied the usage of the bushy logic. The simulations had been carried the use of Matlab Sim strength systems and Fuzzy good judgment toolboxes beneath load configurations, balanced and unbalanced. The outcomes are located quite nice in an effort to keep the switching frequency consistent, and to compensate the modern harmonics, unbalance and reactive strength in three phase electric systems.

[3] Hideaki Fujitaand Hirofumi Akagi, This paper discusses the control strategy of the UPQC, with a focal point at the flow of on the spot active and reactive powers in the UPQC. Experimental effects obtained from a laboratory model of 20 kVA, in conjunction with a theoretical evaluation, are shown to confirm the viability and effectiveness of the UPQC.

[4] Borisov et. al, Shunt active energy filters are used to take away the contemporary harmonics and to improve the electricity factor in structures with non-linear masses. At the prevailing time, extraordinary methods exist to manipulate active energy filters. Some of them are primarily based on on the spot reactive electricity principle and others are based totally at the synchronous reference frame the use of Park's transformation. The motive of this paper is to offer a new manipulate method of shunt lively strength filters in unbalanced systems, both in load currents, and in AC supply voltage, with a high contents of harmonics. The machine has been simulated for one of a kind load and line situations. Waveforms of the line currents are proven, with their harmonic distortion contents.

[5] Ciirdenas et. al, A contrast of 3 one-of-a-kind strategies used for the era of the modern reference signal in shunt energetic strength filters. The three specific techniques are evaluated and as compared in terms of repayment performance below constant kingdom and transient operating situations,

implementations necessities, and reimbursement in 4 cord energy distribution structures, with unbalanced unmarried phase nonlinear hundreds. The 3 techniques analyzed are the immediate Reactive strength concept (PQ theory), the Synchronous Reference body concept (SRF) and top Detection approach (PDM). The technical assessment is achieved by way of considering the robustness for the operation with unbalanced and distorted deliver voltages, unbalanced load currents, manipulate indicators conditioning and processing delays brought with the aid of the. The comparison is based on theoretical evaluation and simulated effects acquired with Matlab. The foremost conclusion is that the repayment overall performance of the distinctive techniques is similar under best conditions, however beneath the presence of unbalanced and voltage distortion, the compensation performance is pretty special, and no longer all the reference techniques lets in complete repayment. The Synchronous Reference body set of rules affords the pleasant performance for extraordinary operating situations.

[6] TingQian et. al, Marshall Molen, Modern army electric ship, the application of a couple of shunt lively energy filters (SAPF) has become an appealing preference to mitigate the current distortion of the nonlinear masses. A couple of SAPF has the benefit of excessive electricity capacity and high reliability. Primarily based on the advent of SAPF, this paper analyzes the significance of paralleling SAPF in electric powered ship structures. A new paralleling approach is proposed and compared with numerous regarded paralleling cascading strategies. The proposed method separates the tasks of compensating for reactive strength and harmonic currents. It has fast reaction and is appropriate for redundancy design. Simulation consequences verify the

analyses.

[7] Koochaki et. al, The most essential part of the lively energy filters is generating of gate signal for inverters. This paper offers unmarried section software of space Vector Pulse Width Modulation for shunt lively electricity filters. In conventional SVPWM, all the section's currents are managed collectively, however on this method each of section currents is managed independently from the measured currents of other levels. In every other word, this approach prevents from have an impact on of different phase's mistakes in the manipulate of considered segment. On this technique, the implementation of control logic may be simpler than the conventional SVPWM. For displaying the performance of proposed technique an ordinary gadget has been simulated by way of MATLAB/SIMULINK. At remaining, the outcomes of proposed approach are as compared with the traditional SVPWM. The effects display that proposed technique have higher overall performance in producing of the repayment present day in energetic electricity filter out.

[8] WanchakLenwari and Milijana Odavic, In latest years, the growth of non-linear hundreds in electric strength system has sparked the studies in electricity, excellent difficulty. The shunt lively electricity clear out (SAPF) is a power digital tool which has been developed to enhance power high-quality. The modern control of shunt strength filters is vital for the reason that bad manage can beef up existing harmonic problems. Various manipulate techniques were proposed by many researchers. In this paper, a comparative evaluation of the overall performance of modern control strategies, resonant and predictive controller, is presented with same machine specification. The layout system and precept of each contemporary control methods also are offered in element. Simulation consequences display the assessment of transient response, constant country manipulate and overall performance within the presence of version of supply impedance between control techniques.

[9] Abellan, et. al, Shunt APFs represent the maximum critical and maximum broadly used filters in business functions, that is due not simplest to the truth that they do away with the Harmonic cutting-edge with a unnoticed amount of active essential cutting-edge

provided to compensate machine losses, but also they're suitable for a wide range of electricity rankings. Contemporary electricity digital gadgets along with IGBTs allowed to configure non harmonic generating shunt APFs, this paper makes a speciality of this sort of configuration specifically the voltage source inverter based three phase shunt lively energy filters aiming to give an overview on the mater.

[10] S. J. CHIANG and J. M. CHANG, APF are commonly used for the discount of modern-day harmonics and improvement of the strength thing in energy systems with nonlinear masses, together with diode rectifiers. A pulse width modulation (PWM) power converter constitutes the primary issue of the APF. The low-order harmonics of the road modern-day are attenuated, however the transfer-mode operation of the converter outcomes in electromagnetic interference (EMI) spreading to the grid. Especially, clusters of harmonics seem inside the frequency spectra of voltages and currents of the converter at multiples of the switching frequency. In this paper, transferring the discrete spectral electricity of those harmonics to the non-stop spectral energy density is proposed as approach for mitigation of the EMI. It is performed by means of randomization of the switching durations using a singular random PWM approach (RPWM II). In comparison to the prevailing random PWM strategies, in RPWM II the sampling frequency of the virtual modulator is steady and equal to the average switching frequency. Laptop simulations and experimental investigation of an APF designed for shipboard energy structures are described, and the outcomes are presented. They exhibit significant reduction of the EMI, a feat carried out at nearly no price.

[11] Jianze, et. al, A unique manage method for shunt energetic electricity filters the usage of SVPWM is presented. Inside the

proposed manage method, The APF reference voltage vector is generated to in place of the reference current, and the preferred APF output voltage is generated by space vector modulation. The manage set of rules is straightforward and may be realized by means of a low price controller. The energetic strength filter out based at the proposed technique can eliminate harmonics, compensate reactive power and stability load asymmetry. A 10kVA laboratory prototype of APF is designed. This prototype adopts the voltage supply inverter as the main strength circuit and occasional price DSP ADMC326 as manipulate center. Simulation and experimental results proves the validity of the evaluation and the feasibility of the APF with the proposed manipulate approach.

[12] Li, et. al, A novel modern detection algorithm based on time domain technique for 3-phase shunt active strength Filters (APF) to eliminate harmonics, and/or accurate power element, and/or balance asymmetrical hundreds is analyzed in this paper. First, a basic review and assessment of the overall performance of 3 present modern detection algorithms for lively energy filters is presented. Consistent with exceptional complicated strength best issues and diverse repayment purposes, a unique modern-day detection algorithm is then proposed. Evaluating with existing algorithms, this algorithm has shorter time delay and clearer physical that means. Extraordinary compensating cutting-edge references can consequently be accurately and easily received by adopting the proposed set of rules. It ensures that a shunt APF can thoroughly obtain special compensation purposes. Furthermore, it is very easy to implement this algorithm in a virtual signal Processor. Simulation effects received with Matlab and trying out consequences on an experimental shunt APF are offered to validate the proposed set of rules.

[13] Zouidi, et. al, A potential-quandary approach to increase the electricity ability that can be handled with the aid of the shunt active strength filters (APFs). The capacity confined consists of the reactive electricity in addition to the amplitude of the distortion present day provided by way of the APFs. Underneath capability-limitation manage $m+1$ APFs supply the burden reactive electricity with m APFs offering their rated electricity and one APF elements a fragment of its rated cost. In addition, $n+1$ APFs supply the load modern harmonic with n APFs imparting the

distortion current confined in amplitude and one APF imparting a fraction of its restricted amplitude. Blessings of the proposed method encompass high flexibility for extending system potential, excessive reliability due to no manipulate interconnection, lowering power capacity call for of APF, excessive modularity because of identical APFs, strong reactive strength and harmonic modern-day sharing and its overall performance is insensitive to parameters mismatch of APFs, fee-powerful due to modularization, and so forth. 3 single-segment 1KVA APFs are designed and carried out. The effectiveness is verified by way of a few experimental consequences.

[14] Jacobina et. al, This paper describes a method to lessen the converter losses inside the shunt active electricity filter operation. In such approach, the reactive and harmonics compensation are separated in two shunt active strength filters operating at different frequencies. The reactive power of the burden is compensated by using low frequency filter, whilst the strength associated with harmonics are compensated by using high frequency clear out.

[15] González, et. al, The evaluation and the utility of a modern controller in an active energy filter (APF) primarily based on a PWM voltage-supply digital converter with 3 legs and 4 wires. The neutral wire is hooked up to the center point of the DC-capacitor voltage. The controller proposed right here is an extension of the one proposed for a three-twine Shunt energetic strength clear out. The controller is a two-level nested controller. The outer loop generates the reference modern for the internal-loop. The latter, is a country-remarks modern-day controller with essential action. The former includes (i) a selective harmonic elimination technique and (ii) a DC capacitor-voltage controller. This paper will attention at the impartial-

twine modern control and on the balance manage of the DC-capacitor voltage. The overall performance of the manage algorithm has been verified using a test-rig with balanced and non-balanced non-linear hundreds.

[16] Parimala et. al, This paper provides the development of energy exceptional in 3 section 4 cord machine with balanced and unbalanced source situation based on three segment shunt lively strength filter. The PI controller is used to modify the DC hyperlink voltage. The synchronous reference frame (SRF) approach is used for extracting reference modern. The PWM controller is used to generate gate pulses and applied to a few phase VSI primarily based shunt lively strength clear out with split capacitor topology. The primary purpose of this paper is to lessen the whole harmonic distortion (THD) in the source cutting-edge. The MATLAB/Simulink environment is used to model for 3 segment supply and nonlinear load is attached to the device.

[17] Boukezata et. al presented A paper wherein active filter is used to compensate the reactive strength and to inject energetic strength simultaneously each time needed through the nonlinear loads. The PV array version with raise converter and MPPT controller is immediately related to the dc-facet voltage supply inverter (VSI) and the PV machine is attached to the grid through this inverter using direct strength manipulate set of rules.

[18] Chaitanya et. al described The PV array mathematical modeling and also the MPPT algorithm implementation on a lift converter to song maximum power during fast alternate in surroundings situations. The whole PV version is simulated and P-V and i-V curves are drawn the usage of MATLAB/SIMULINK and the results are discussed from which it is clean that the P-V and i-V curves are depending on temperature and irradiation. The use of MPPT set of rules, a PV machine may be operated at maximum performance.

[19] Jeevanathan et. al described that A SAPF is a present day accomplish mechanism that is used for discount of harmonics in current by way of injecting a contemporary of identical importance but opposite in segment of the harmonics in cutting-edge and

additionally reactive cutting-edge made out of the non-linear loads such that simplest fundamental lively currents may be provided from the ac supply to the masses. This method is used for each harmonic discount along side reactive reimbursement produced because of non-linear loads. As a end result, efficiency of the device is improved with decreased price of THD in supply contemporary .

[20] Remya et. al discovered that Due to boom in energy demand, the power distribution additionally improved so Renewable electricity resources (RES) are linked to the distribution systems in which inverter, converter and non-linear hundreds are present consequently, harmonics are found in currents and electricity satisfactory decreases. So, they used to lessen the harmonics as well as for reactive strength repayment. Here, the PV machine is connected to the grid via a three-phase inverter which is used as a multi-useful tool as it's far used as electricity converter additionally for harmonics removal.

[21]Blorfan et. al a delivery note the place a hybrid three-phase active power filter(HAPF) is configured or a languid high-pass filter is related among comparison including an energetic power filter or since in conformity with a photovoltaic system. This mass is capable in conformity with enhance the filtering capability regarding an active filter (APF) the usage of sliding anger monitoring or used to be capable to filter oversea short strip so nicely so wideband harmonic

[22] Belaidi et. al described the evaluation or simulation concerning shunt active filter (SAPF) the place a PV system is connected in accordance with shunt power active filter or it be able keep used because the harmonics removing who is generated by using a nonlinear load yet additionally active power amends is made here. For the reference current calculation regarding Shunt Active Filter We are the usage of the

synchronous d-q-o reference frame algorithm (SRF) yet the carrier-based PWM modulation is old because gating signal era for the voltage supply inverter.

Conclusion

Electronic power equipment leads to harmonized pollution of the power transmission or distribution system. The research of many researchers in electrical systems automation has led to different approaches to solving the problem. One way was open by introducing harmonic compensation using Shunt Active Filters. In this dissertation we explain the coherence of the current system, the inverter circuit for a three-phase circuit shunt active filter is modeled, THD measurement governs the lack of harmonic based shunt active filter. Shunt AF is capable of compensating for balanced, unbalanced non-linear load currents in a four-wire system with a neutral wire connected to the center point of the capacitor.

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